Electrical Power Engineering (2)

Code: EP2207

Lecture: 4 **Tutorial: 4** **Total: 8**

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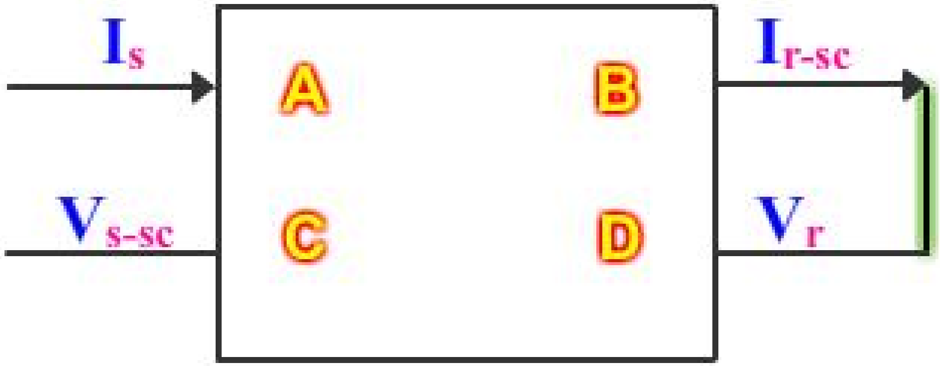
Experimental Determination of the General ABCD Constants of TLs

Short circuit on the receiving–end of transmission line



$$V_s = AV_r + BI_r \longrightarrow V_{s\text{-}sc} = BI_{r\text{-}rs}$$

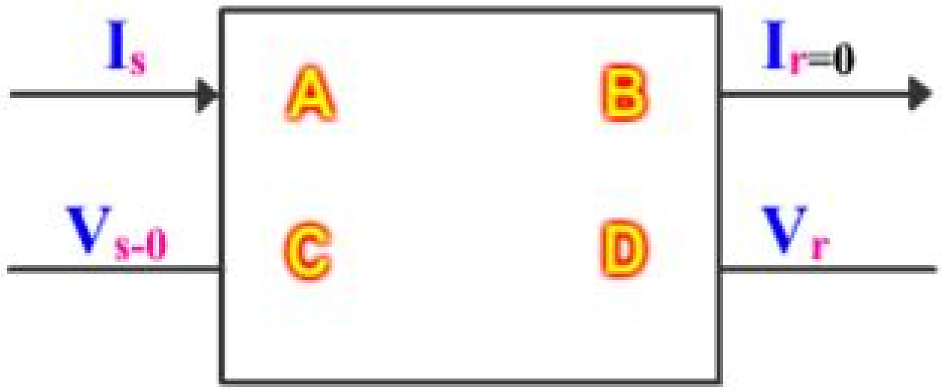
$$I_s = CV_r + DI_r \longrightarrow I_{s\text{-}sc} = DI_{r\text{-}sc}$$

$$B = \frac{V_{s-sc}}{I_{r-sc}}$$

$$D = \frac{I_{s-sc}}{I_{r-sc}}$$

Experimental Determination of the General ABCD Constants of TLs

Open circuit on the receiving–end of transmission line



$$V_s = AV_r + BI_r \longrightarrow V_{s\text{-}0} = AV_{r\text{-}0}$$

$$I_s = CV_r + DI_r \longrightarrow I_{s\text{-}0} = CV_{r\text{-}0}$$

$$A = \frac{V_{s-0}}{V_{r-0}}$$

$$C = \frac{I_{s-0}}{V_{r-0}}$$

Power Circle Diagrams

The following equations determine the current and voltage at any point on a given transmission line

$$V_s = V_r \cosh(\theta) + I_r Z \frac{\sinh(\theta)}{\theta}$$

$$I_s = I_r \cosh(\theta) + V_r Y \frac{\sinh(\theta)}{\theta}$$

$$V_r = V_s \cosh(\theta) - I_s Z \frac{\sinh(\theta)}{\theta}$$

$$I_r = I_s \cosh(\theta) - V_s Y \frac{\sinh(\theta)}{\theta}$$

Power Circle Diagrams

For balanced conditions, the current and voltage at one end of the transmission line can be expressed as a simple linear function of the current and voltage at the other end

$$V_s = A\,V_r + B\,I_r$$

$$I_s = C\,V_r + D\,I_r$$

$$V_r = D\,V_s - B\,I_s$$

$$I_r = A\,I_s - C\,V_s$$

Power Circle Diagrams

Current and voltage at one end of the TL can be expressed as functions of current and voltage at the other end

Notice : The general line constants (A, B, C and D) are all complex quantities and each have both magnitude and direction. Assume that:

$$A = A\angle\alpha \qquad B = B\angle\beta$$

$$C = C\angle\gamma \qquad D = D\angle\delta$$

$$V_r = D\,V_s - B\,I_s$$

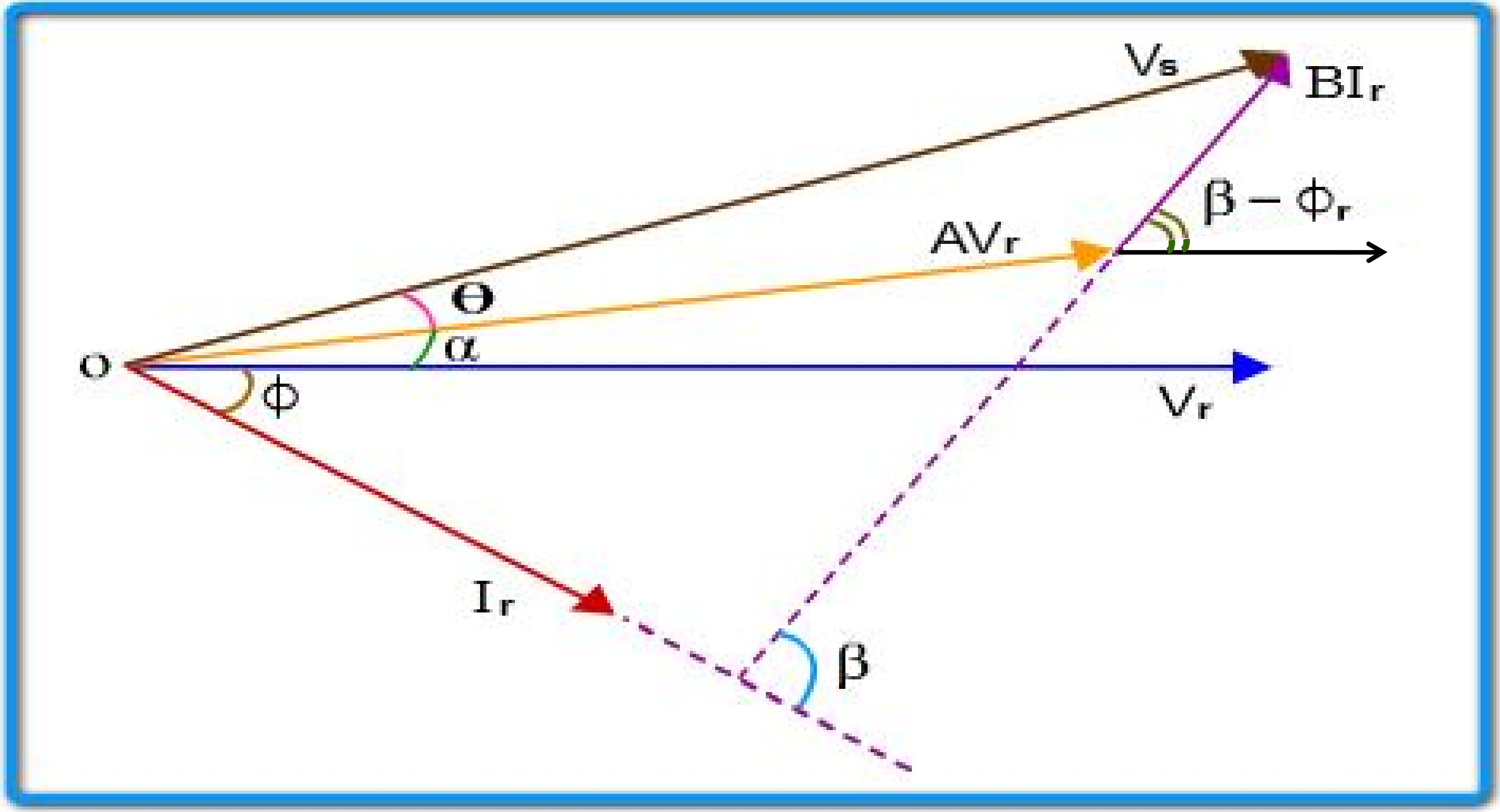
$$I_r = A\,I_s - C\,V_s$$

$$V_s = A\,V_r + B\,I_r$$

$$I_s = C\,V_r + D\,I_r$$

Receiving-end Power Circle

$$V_s = A\,V_r + B\,I_r$$



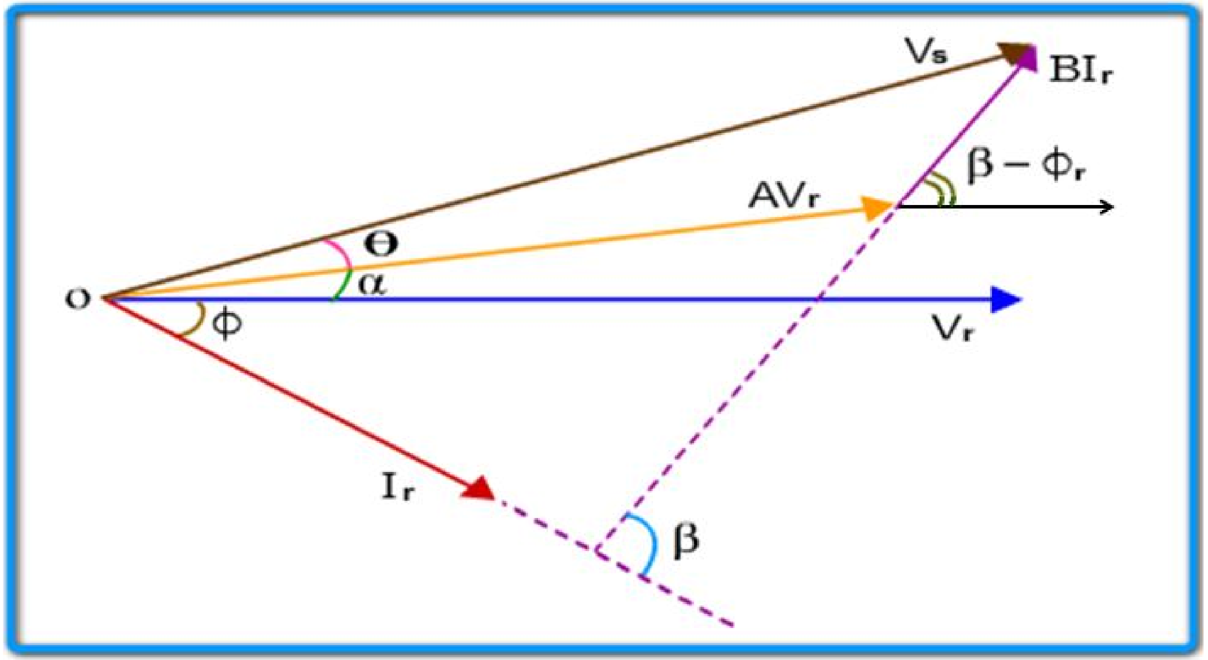
Receiving-end Power Circle

This diagram can be modified by dividing each vector by the complex quantity B

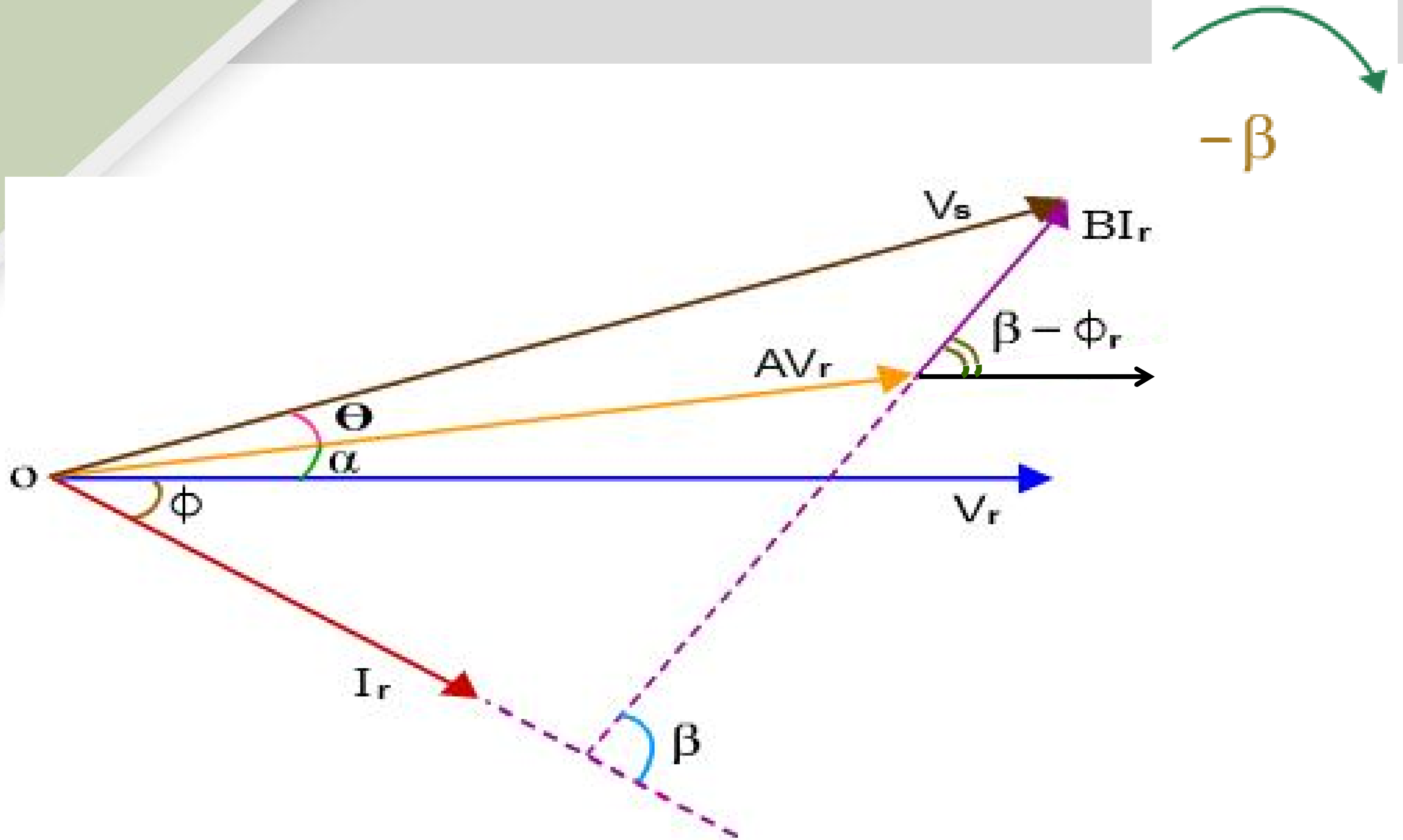
Regarding the magnitudes, it is enough to change the scale of the diagram

The diagram has to be rotated through an angle -β (i.e. clockwise)

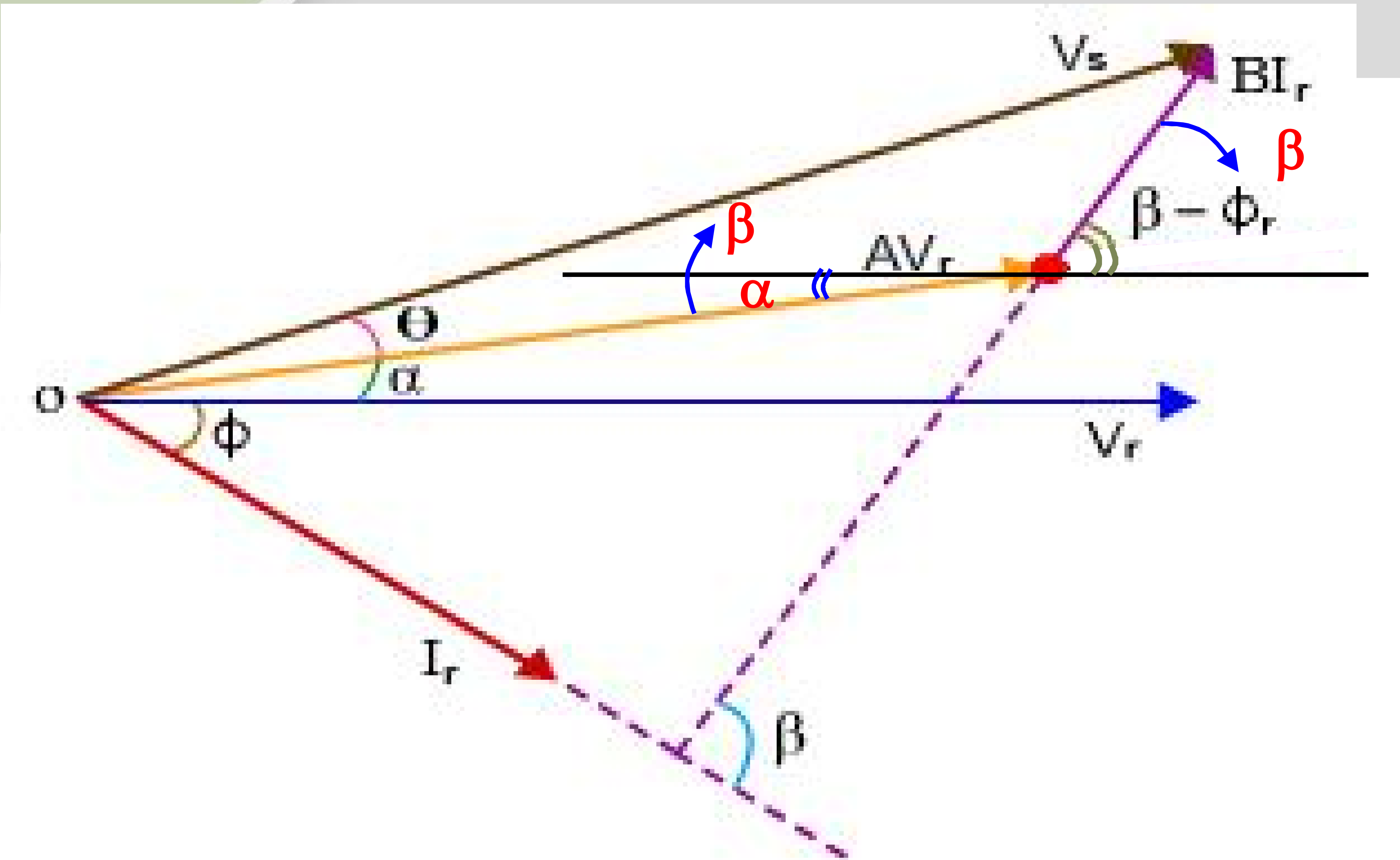
The active component of receiving-end current, i.e. $I_r \cos(\varphi_r)$, is aliened with the reference vector



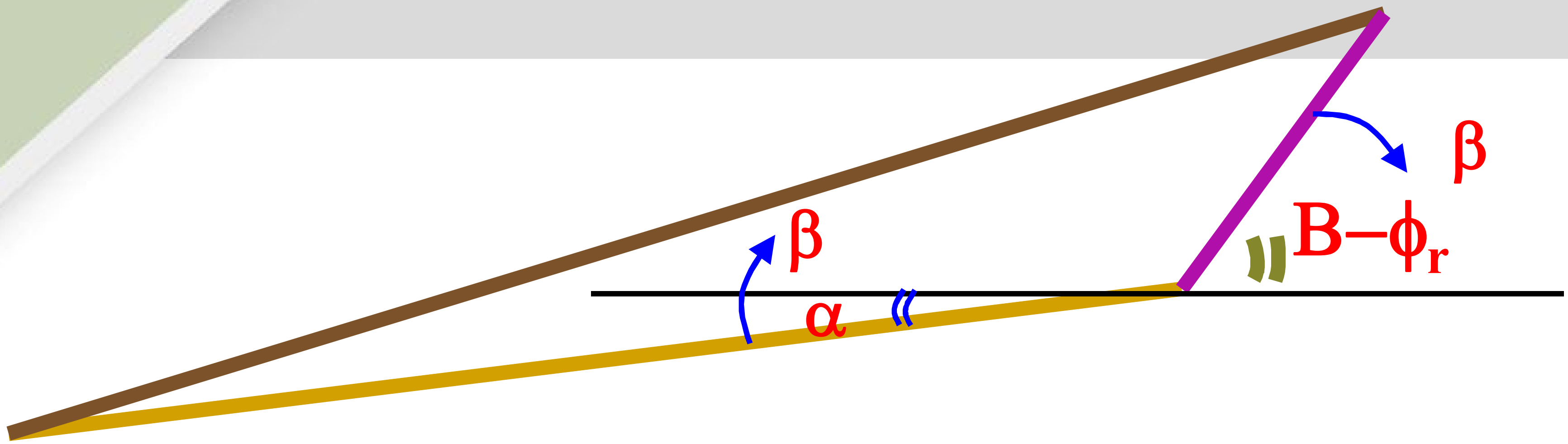
Receiving-end Power Circle



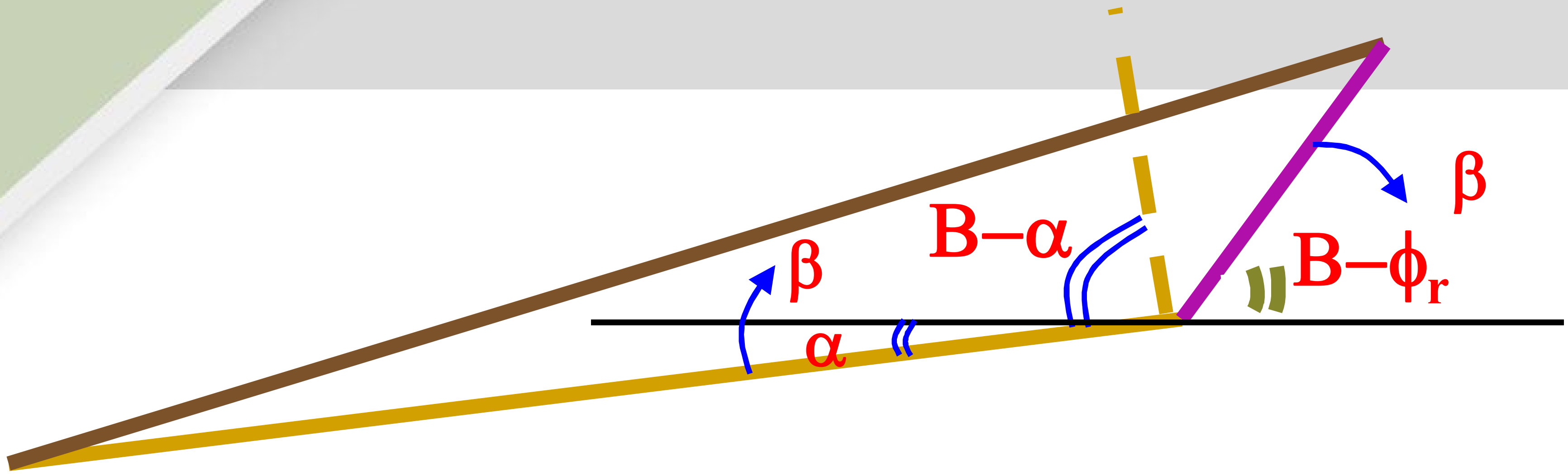
Receiving-end Power Circle



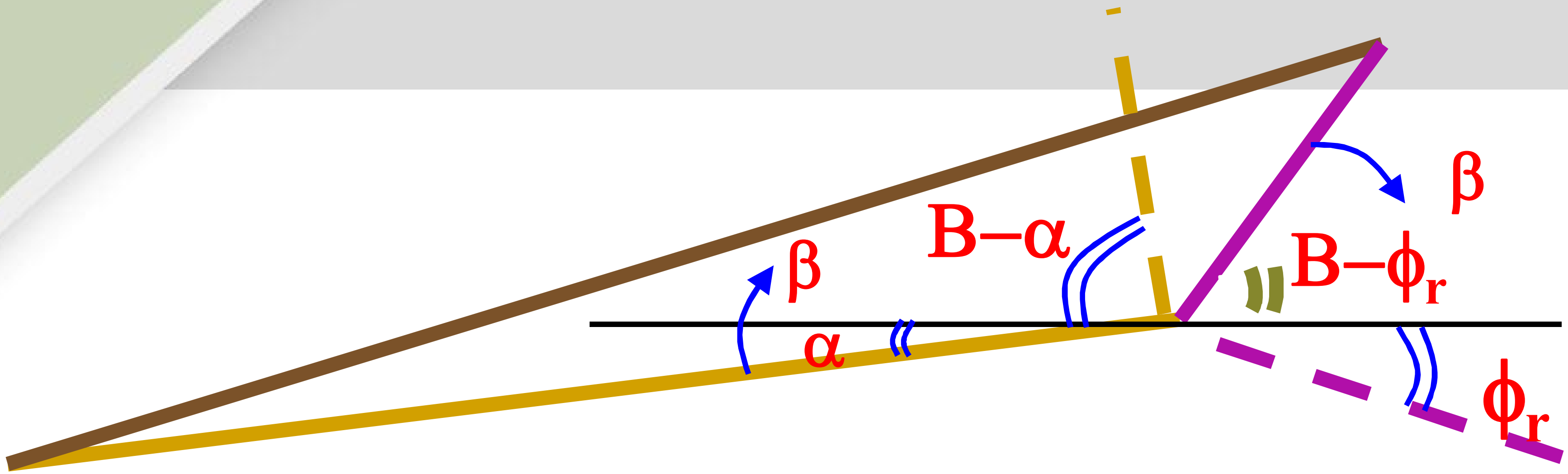
Receiving-end Power Circle



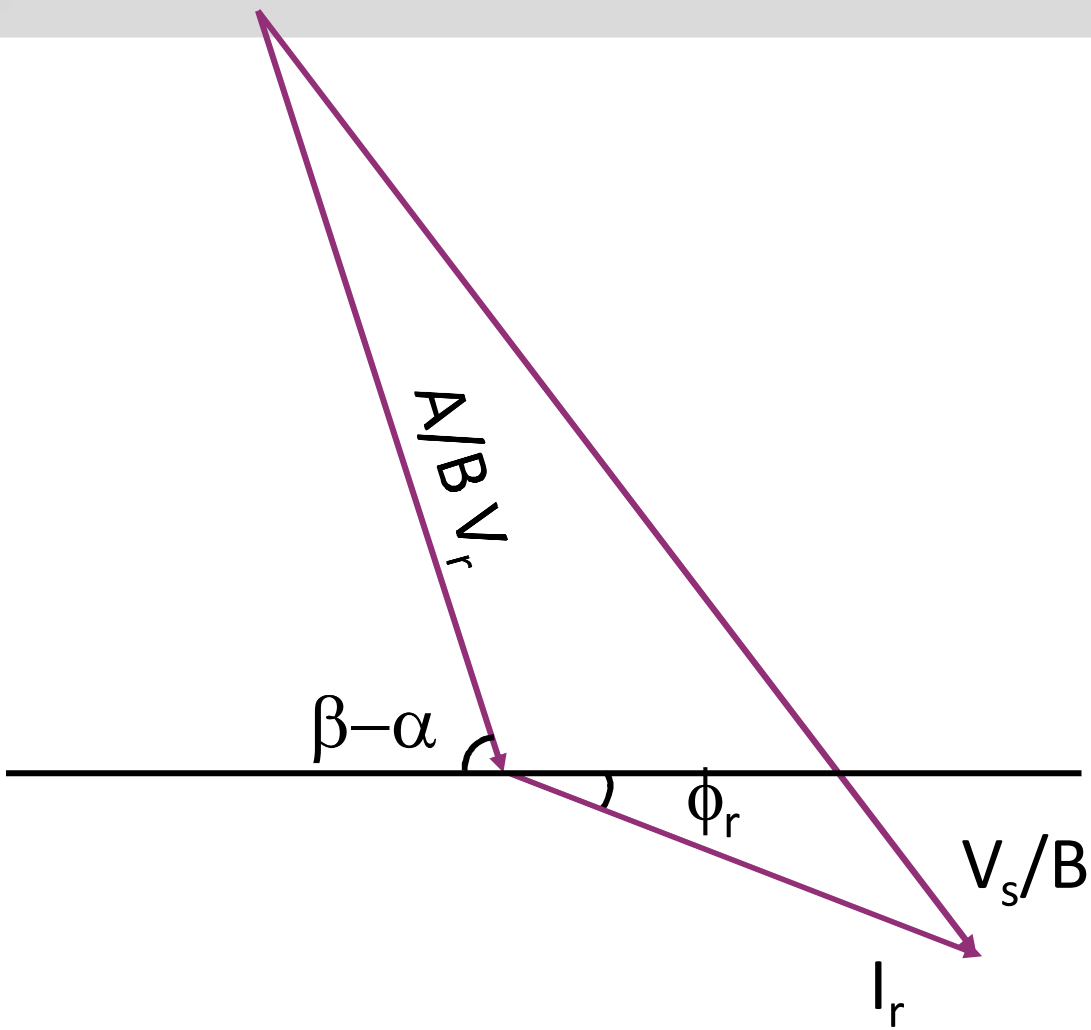
Receiving-end Power Circle



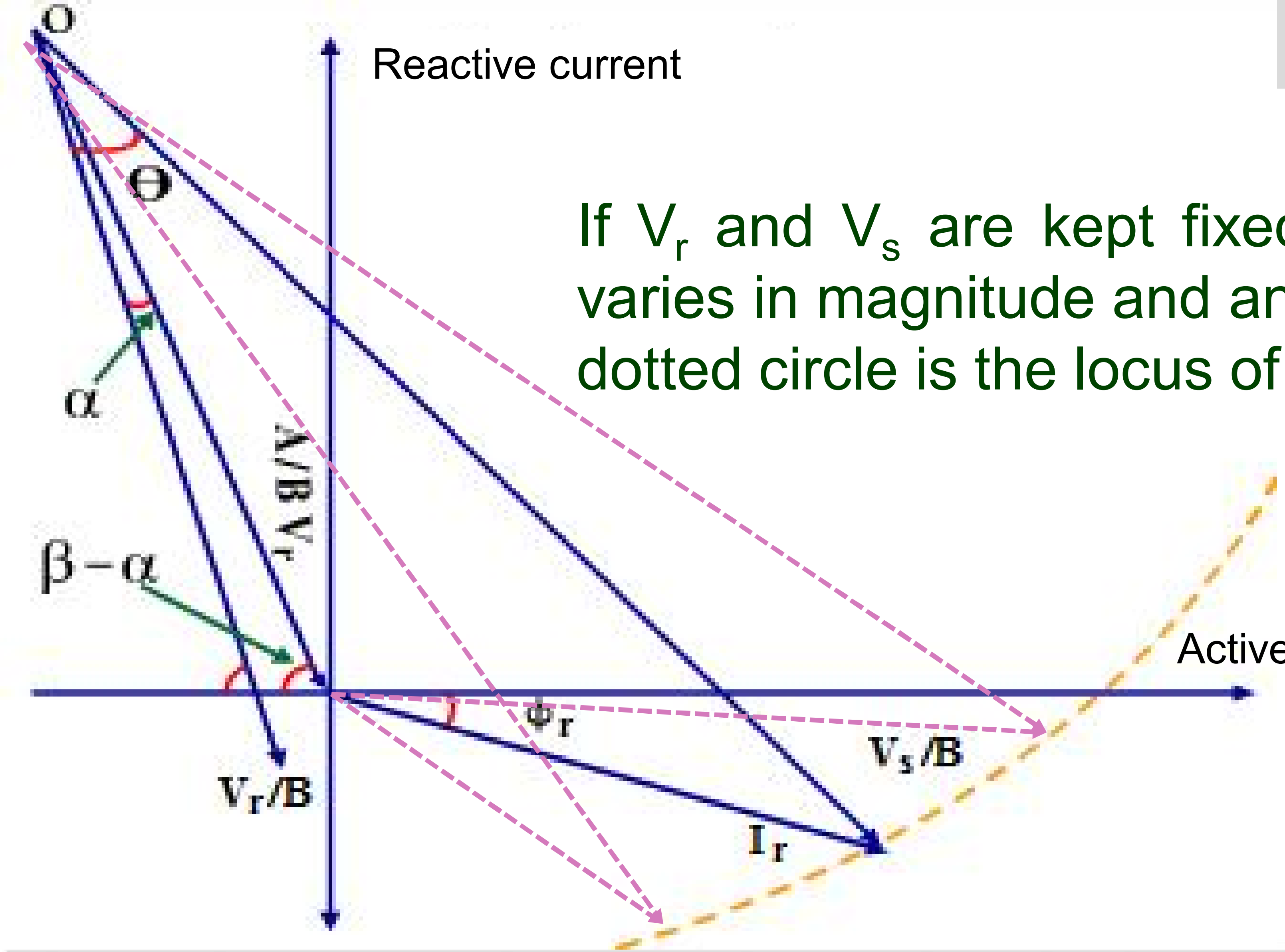
Receiving-end Power Circle



Receiving-end Power Circle

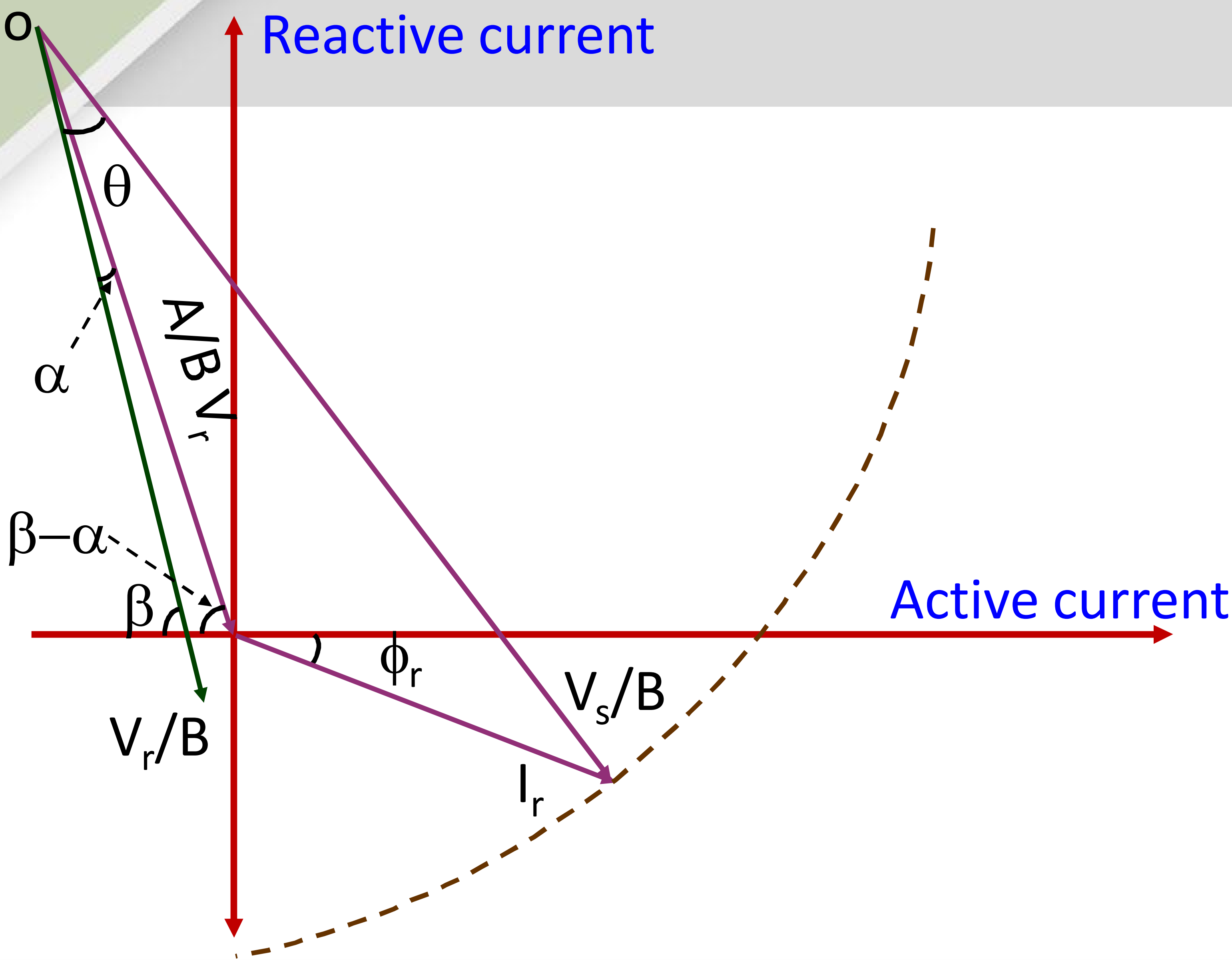


Receiving-end Power Circle



If V_r and V_s are kept fixed and I_r varies in magnitude and angle, the dotted circle is the locus of I_r

Receiving-end Power Circle



Receiving-end Power Circle